Space Weather Technical Forecast

Issued on Sunday, 18 August 2024 at 13:02 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1 Minor Storms now fading. Occasional M-class flares Expected, with a Chance of X-class.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured at GOES16 was Moderate, with at least four low M-class flares from well-separated sources in the northwest (AR3784) and southeast (AR3790). The peak of these events was an M2.4 at 18/0204UTC from AR3784 in the northwest of the solar disc. AR3784 itself remains a large and complex group comprising one large delta spot, but now is seeing proliferation and spreading of minor northern spots, and it is the northeastern part of the group that has spawned recent activity.

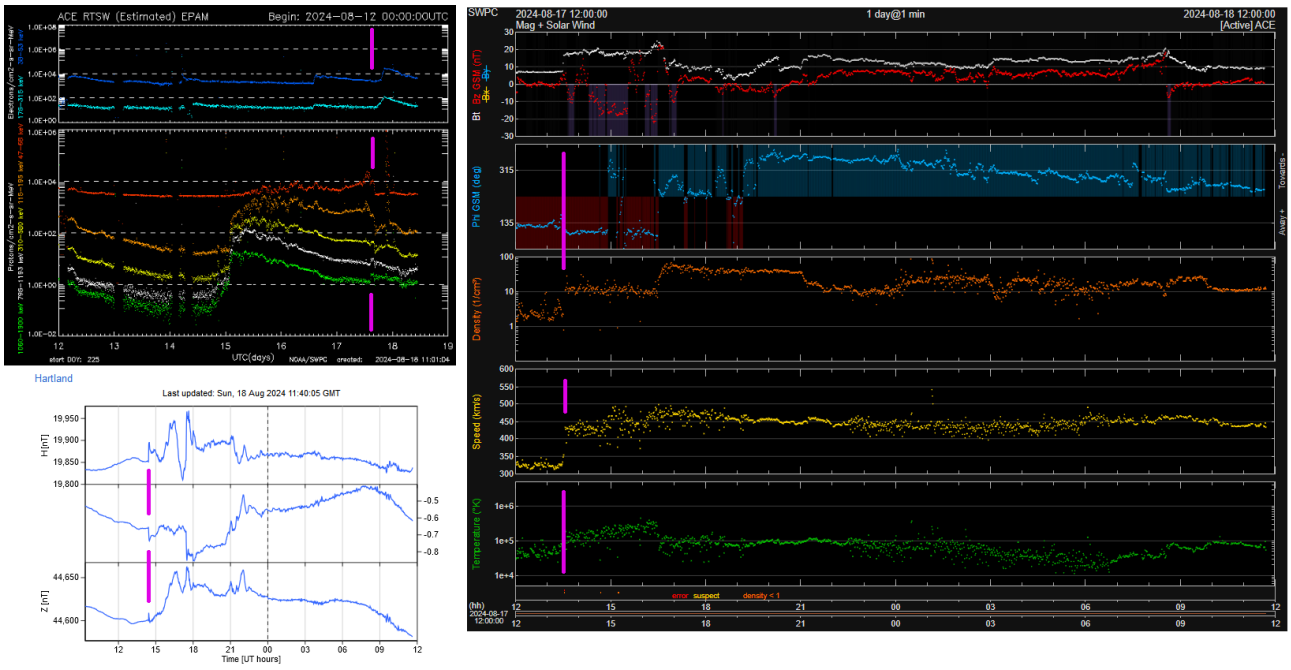

Figure 0: Numerous measures of the 14 August X1.1 CME arrival (magnetia line on all plots) at 17/1330UTC – clockwise from top left: NOAA SWPC visualisation of ACE EPAM LEMS over past seven days, showing minor precursor rise in low energy protons ahead of the CME hit; NOAA SWPC L1 solar wind measures at ACE for past 24 hours; BGS Hartland magnetometer, showing 40.0nT sudden impulse at 17/1425UTC and subsequent disturbed traces.

There are now up to ten regions on the disc, with AR3783 having rotated off the western limb. On the eastern limb, a new unnumbered bipolar region is now becoming visible - this appears potentially magnetically complex and may yet reveal a Mt Wilson delta spot with further rotation. The main changes in the period were some intermediate penumbral sunspot development in AR3790 in the southeast, such that group is now compact and has some complex polarity mixing. The congestion in this group may yet lead to some Mt Wilson delta spots developing, however at

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the time of writing there was narrow separation between the opposing polarity umbrae. Finally, both of the recently numbered northeastern regions saw slight growth, while AR3785 in the southwest saw the opposite tendency.

Narrowly before the current 24-hour period, a high-coronal reconfiguration was evident across 40N in SDO AIA211 imagery from around 17/1030 UTC, with a subsequent Coronal Mass Ejection (CME) observed. This appeared to be sparked by activity within AR3784, and was repeated at an even higher solar latitude (perhaps 60N) around 18/0500UTC (north of CH58/-). This earlier event is expected to pass narrowly north of Earth on day 4 (Wednesday 21 August), however a glancing influence cannot be completely ruled out. The second event is more comfortably off-ecliptic.

Two final possible CMEs from AR3784 in the northwest around 18/0730UTC and 18/1030UTC are awaiting imagery for analysis, although these are provisionally quite far west for impacts. No Earth-directed CMEs are confirmed at the time of writing.

Solar Wind / Geomagnetic Activity: Solar winds measured at L1 by ACE showed an initial slow regime that was soon interrupted by the anticipated X1.1 flare CME arrival from 14 August. This feature arrived at L1 at 17/1330UTC, with a 55-minute transit time to Earth to deliver a 40.0nT BGS Hartland H-component sudden impulse.

Solar winds rose from background levels near 325km/s to peak near 475 in the UTC afternoon, later moderating to nearer 450. The solar wind density underwent a stepwise increase from single figures ppcc to 10 after 1330UTC and then again to 67ppcc after 1630UTC as the character of the CME changed. The IMF rose from background to a peak of 25nT, before moderating as the density increased, although a recurrence of the higher values was seen late in the period - reaching 21nT at 18/0830UTC before again moderating. The north-south component was very erratic at first, with an absolute range of +/-22nT, however this became weakly co-aligned with time and much of the magnetic cloud's vector changes were seen in the By component to limit further geomagnetic activity. The phi angle was mainly positive (away from the Sun) until 17/1630UTC, then becoming predominately negative to perhaps suggest some influence from the northern coronal hole CH58/- (along with some CIR or current sheet given the high densities involved).

Geomagnetic activity was Quiet at first, but rose to G1 Minor to G2 Moderate storm 17/1500-2359UTC. The interval 17/1500-1800UTC was reported as a provisional G3 Strong storm (Kp 7-), but has subsequently been downgraded to a G2 (Moderate, Kp 6+), with Quiet to Unsettled activity then rounding out the 24 hours.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at Background levels, despite the sustained cadence of M-class flares.

High energy electron flux (greater than 2MeV) observed at GOES16 was mainly at Normal Background, but saw a rise to a Moderate peak of near 250pfu during the UTC afternoon of 17 August. The 24-hour fluence was below the Active threshold, with 2.99e6 integrated pfu observed at 18/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is Expected with further occasional M-class flares, and a Chance of isolated X-class flares, perhaps now bolstered by a new eastern limb arrival. These risks reduce slightly midweek UTC as the most active region of late (AR3784) progressively crosses onto the far-side.

Solar Wind /Geomagnetic Activity: There are now no Earth-directed CMEs, however the broad coronal reconfiguration CME from the north-disc on 17 August has a small chance of giving a close pass on day 4 (Wednesday 21 August). Otherwise, ongoing X1.1 CME effects - perhaps enhanced

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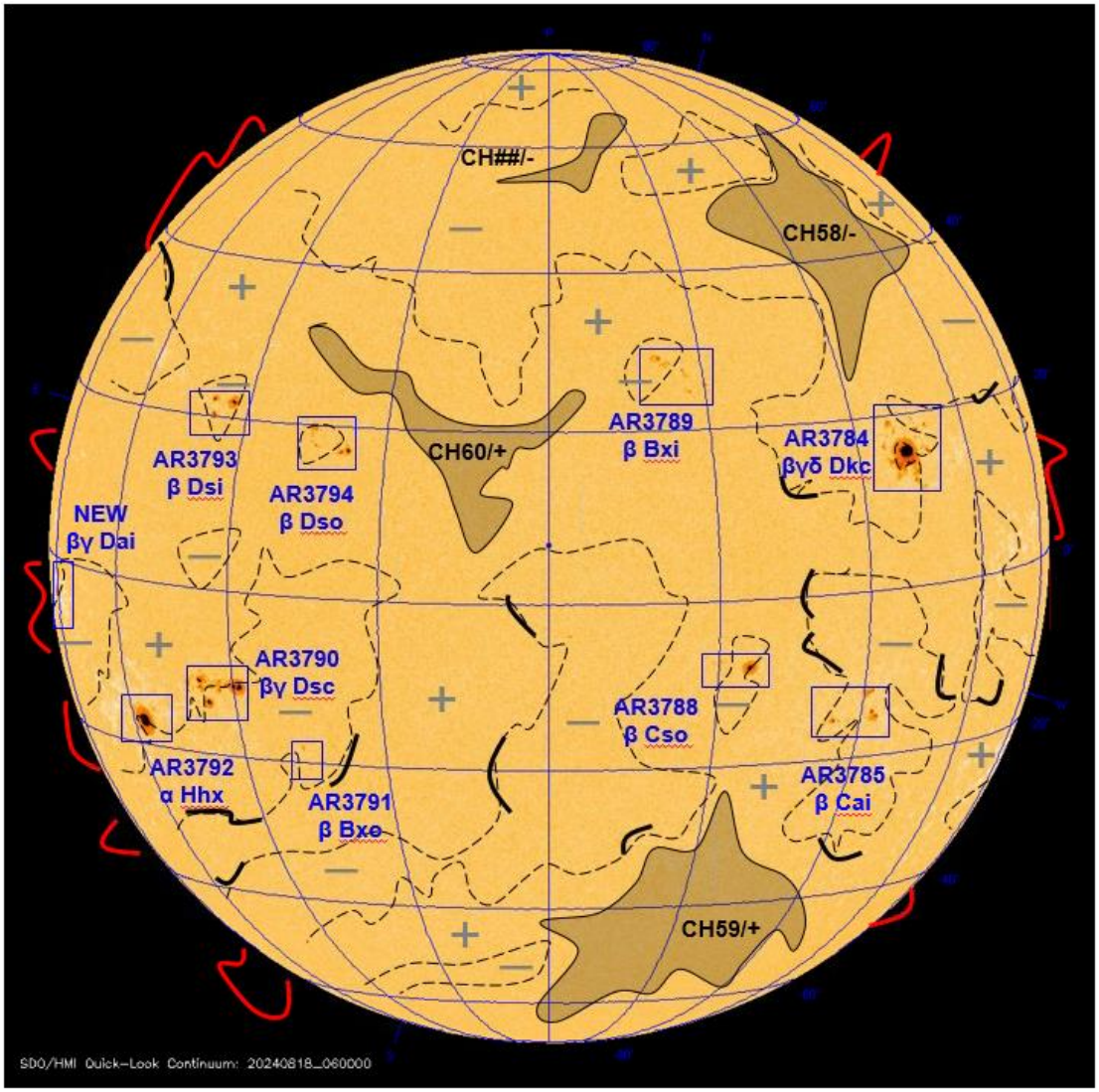
by some interaction from any fast wind from the northern coronal hole CH58/-, are possible early on day 1 (18 August) before easing later in the UTC day.

Solar winds should then ease to background day 2 (19 August) onward. Mainly Quiet conditions are expected, however there is a Slight Chance of Active to G1 Minor Storms from any ongoing CME influence early on day 1 (18 Aug).

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at Background, with a Slight Chance of breaching S1 Minor solar radiation storm level should any notable flares occur, primarily from AR3784.

The high energy electron flux is expected to remain at mostly Normal Background levels at first, but with a Chance of increasing to Moderate at times as solar winds ease later in the period. The associated 24-hour fluence is expected to be below the Active level.

Figure 1. Solar Analysis Valid 18/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

Ongoing CME affects are possible at first on day 1 (18 Aug) in the wake of the X1.1 flare CME that left the Sun on 14 August. The only other CME of note appears to be from a broad upper coronal reconfiguration, occurring from around 17/1030UTC. This resultant CME is likely to pass north of Earth, but has a small chance of giving glancing impacts on day 4 (21 August).

Alongside the current waning X1.1 CME, it appears possible that Earth is seeing some influence from the northern disc coronal hole, CH58/-. Any fast wind influence from this feature is likely to gradually ease later day 1 (18 August), with mainly background winds expected to return from day 2 (19 August).

As a result of the above, there remains a chance of G1 Minor Storms early in the remainder of the current UTC day (18 August) given the current Slightly Elevated winds and resurgent IMF - especially the case should we see any protracted southward Bz. Geomagnetic activity should then likely ease to mainly Quiet to Unsettled day 1 (18 August), then mainly Quiet with only isolated Unsettled intervals day 2 (19 August).

Late in the current four days, there is now an increased possibility of some minor influence from CH60/+, which has seen its leading edge change as a result of high solar latitude coronal disturbances in the past 24 hours. This is something of an unknown quantity at present, but any late arrival coupled with the small chance of CME on this date gives a token 5% Slight Chance of G1.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	1	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/2001	Partial?	High corona	40N, across centre-disc	368km/s	Crosses 1AU 21/2100UTC	Most liekly miss, but may interact with any CIR leading CH60/+ and glance Earth

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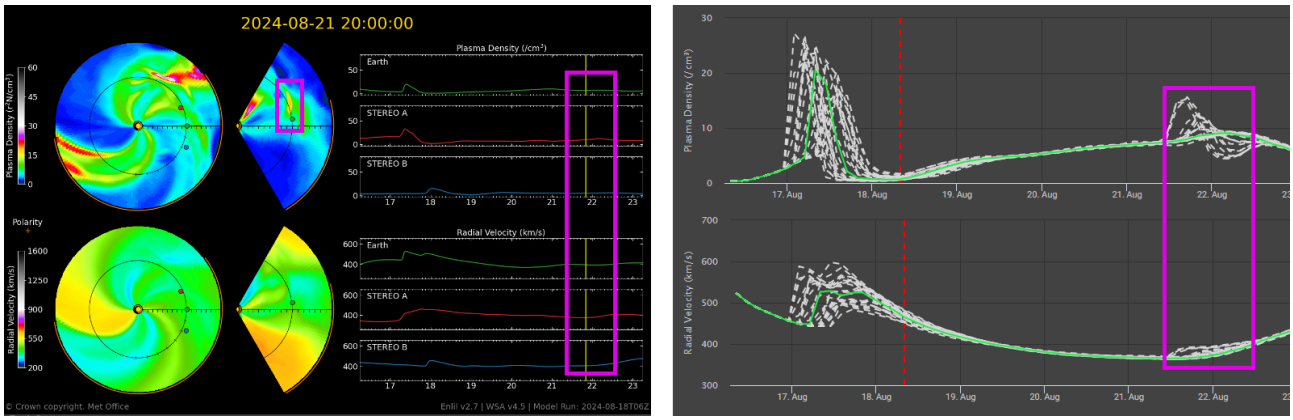
Figure 2: Latest MOSWOC Enlil run (badge time 18/0600UTC), paused at the 1AU crossing time of the 17/1030UTC 40N high coronal CME. This analysis was low confidence and slightly nebulous in origin, however there is a chance shown in the ensemble of a close pass late on 21 August. On its own this may not feature, but a reconfigured CH60/+ may also nudge activity towards the G1 mark. The most likely state of affairs remains the unmodified deterministic run, where these features are absent (left hand plots).



Radio Blackouts - X-Ray Flares:

There are now up to ten sunspot regions on the visible disc, perhaps now bolstered by a new eastern limb arrival that appears bright in AIA094. AR3784 remains the most likely significant flare source, despite its relative modest size and lack of recent notable activity. This has maintained a persistent strong delta spot to the south of its main umbra region, and sunspots with this north-south configuration have historically proven capable of producing some larger flares. However, given the relative small size and lack of activity, this is now considered only a low likelihood.

Other regions on the facing side are generally smaller and less complex, however there has been a recent growth trend in both AR3785 in the southwest and AR3790, both of which have more complicated beta-gamma magnetic structures, and the latter is now a Zurich compact region with potential for some small deltas in its intermediate region.

Growth has also been ongoing in the simpler regions in the northeast, AR3793 and AR3794, and the eastern solar horizon is expected to increasingly reveal further regions in the immediate term that are forming complex links with the cluster including AR3790.

The recent forecast of Expected M-class is maintained for much of the period, moderating slightly on day 4 (Wednesday 21 August) as AR3784 crosses to the far side.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	70
Very Active	R3 to R5 X Class	No	25	25	25	15

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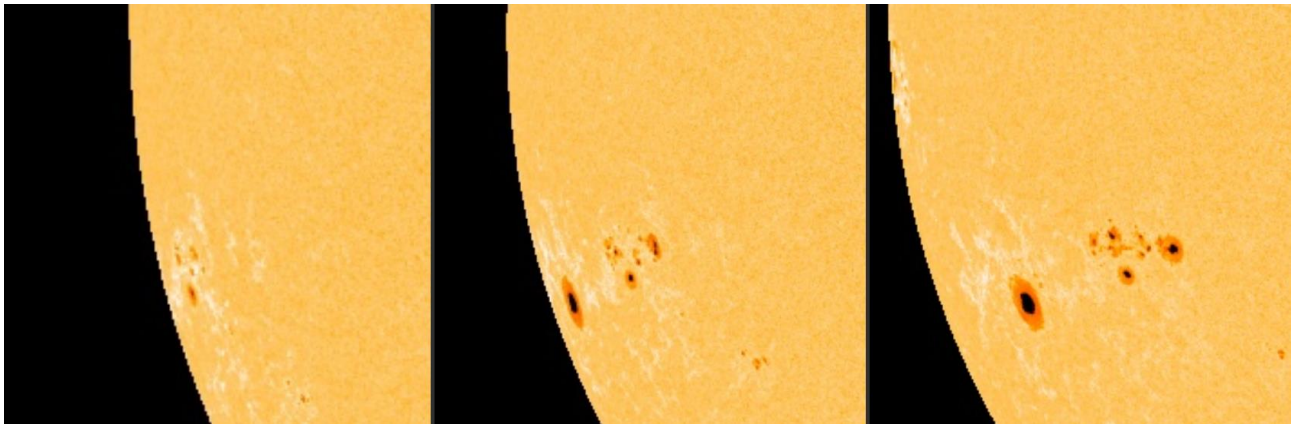
Figure 3: HMIIF imagery sequence for 00UTC on 16, 17 and 18 August of the arriving southeastern sunspot region cluster. Foremost amongst these at present is the Dsc/BG of AR3790, with M-class flares to its name, however note the new region on the extreme upper left of the third frame which appears bright in EUV and may be a further group to watch.



Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES18 is expected to persist at Background, but potentially rising in response to any notable flares. Such events are considered most likely from AR3784 on the northwest visible disc, but potentially also from Ex-AR3780 early in the period, with this region now just over the southwest limb. There are also a few other regions on the western disc that could develop further and bring the potential for increases in the proton flux. Any rise will bring a Slight Chance of reaching the S1 Minor Radiation Storm level, and potentially higher, given the non-zero chance of a larger X-class flare.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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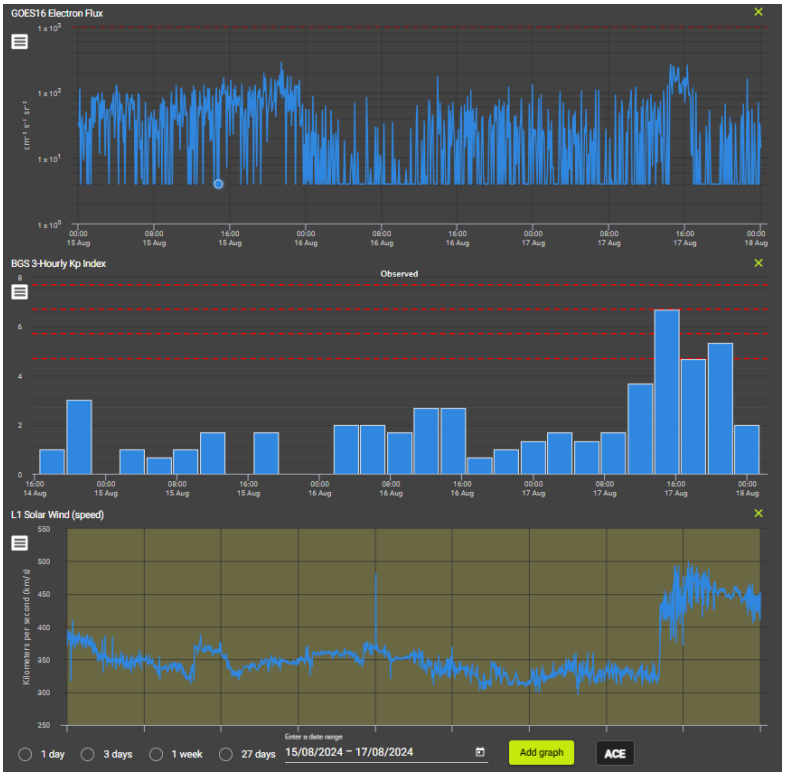
High Energy Electrons Event (≥ 2MeV):

High energy flux, observed by GOES16 at GEO, showed a slightly unusual behaviour in the past 24 hours whereby it increased for a time after the onset of what was a significant CME. This did coincide with the typical late UTC afternoon peak in flux levels, however it is still potentially an additional effect. This may be due to orbit promotion from the relatively populated LEO, however these brief Moderate flux levels were soon displaced inwards as pressure from the incoming solar wind swept the outer belt decidedly inside GEO.

As the current CME-dominated environment eases there is a chance of Moderate levels returning, and perhaps in fact approaching High at diurnal peak. The associated 24-hour electron fluence will most likely remain below Active, but could see a rising trend later in the period. MOSWOC REFM is currently showing a relatively flat trend, however this has no mechanism to account for the recent elevated solar winds from the CME arrival and possible non-persistent coronal hole interaction.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: 72-hour period of measures from GOES16 2MeV electron flux; BGS 3-hourly Kp index and ACE solar wind speed, showing a definite rise in flux levels after the onset of the CME before eventually reducing at GEO.



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